

STUDY OF BRAKE SYSTEMS PERFORMANCE BY THE FINITE ELEMENT METHOD

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Optimizing friction braking systems is key to ensuring safety and increasing production efficiency. Computer simulation enables detailed analysis of brake system performance, justifying more reliable and durable lean solutions for a wide range of industrial applications, from individual components to robotic smart production lines. Modern production processes place high demands on the reliability and durability of equipment, including brake systems. Computer modeling, in particular, with the help of LS-DYNA software packages, provides a powerful tool for detailed analysis of the behavior of such systems under various loads and operating conditions. The purpose of this study was to develop a methodology for assessing the impact of material characteristics on the operation of pneumatic stoppers widely used in robotic systems of packaging lines. For this purpose, a detailed numerical analysis of the three-dimensional model of the stopper was carried out in the LS-DYNA environment. The model took into account the geometric features of the structure, material properties of the components, and characteristic loading modes. The modeling results showed a high sensitivity of the stopper behavior to changes in the materials of the friction pairs. The use of bronze as a material for the jaw resulted in significant plastic deformation and rapid wear due to cyclic loads. This leads to a decrease in the efficiency of stem fixation, an increase in backlash in the joint, and, as a result, to premature failure of the entire mechanism.

For a more detailed analysis of the processes occurring in the contact zone of friction pairs, a study of the distribution of stresses and strains was conducted. The results made it possible to identify critical zones subject to the highest loads and estimate the intensity of material wear.

The research led to the following conclusions: material characteristics have a significant impact on the durability and reliability of pneumatic brakes; bronze, as a material for friction jaws, has limited durability under cyclic loads. The modeling results confirm the hypothesis that cyclic loads on the crimping surface of the bronze sponge cause significant plastic deformations. This leads to a decrease in its geometric dimensions, a change in its original shape, and, as a result, a decrease in the efficiency of stem fixation. In parallel with the deformation, intensive wear of the sponge material occurs due to abrasive and adhesive effects on the surface of the stainless steel rod.

The results obtained can be used to develop new design solutions and select optimal materials for friction pairs.

Keywords: *pneumatic stops, computer modeling, materials, wear and tear reliability*

References

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